Thus, if the resistor's voltage is a complex exponential, so is the current, with an amplitude

$$I = \frac{V}{R}$$

(determined by the resistor's ***v-i*** relation) and a frequency the same as the voltage. Clearly, if the current were assumed to be a complex exponential, so would the voltage. For a capacitor,

$$i = C\frac{d}{dt}(v).$$

Letting the voltage be a complex exponential, we have

$$i = CVj2\pi f e^{j2\pi ft}.$$

The amplitude of this complex exponential is

$$I = CVj2\pi f.$$

Finally, for the inductor, where

$$v = L\frac{d}{dt}(i),$$

assuming the current to be a complex exponential results in the voltage having the form

$$v = LIj2\pi f e^{j2\pi ft},$$

making its complex amplitude

$$V = LIj2\pi f.$$

.

The major consequence of assuming complex exponential voltage and currents is that the ratio

$$Z = \frac{V}{I}$$

for each element does not depend on time, but does depend on source frequency. This quantity is known as the element's **impedance**.

Impedance

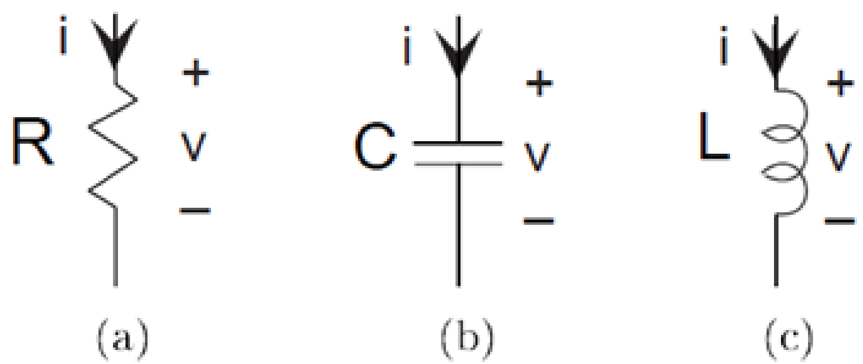

Figure 3.24 Independence

(a) Resistor:

$$Z_R = R$$

(b) Capacitor:

$$Z_C = \frac{1}{j2\pi fC}$$

(c) Inductor: